Ms Thesis Proposal 1:

Optimization of RF GaN transistors

Supervisors: Bertrand Parvais (VUB/imec) / Piet Wambacq (VUB/imec) / AliReza Alian (imec)

Abstract

The fifth generation of cellular communication (5G) promises a tenfold increase in data rates and the millimeter-wave (mmWave) spectrum bands represent an opportunity for these extremely broadband mobile communication because of the large available bandwidth at these frequencies. The high manufacturing volumes expected for 5G user equipment devices favor low-cost and high-integrated technologies, which are typically today Si based. Unfortunately, these technologies are un-efficient in mmWave power generation. The current research in the field aims therefore to develop devices which can be manufactured at large scale while capable of generating efficiently mmWave power.

In this Ms thesis, you will characterize and model the advanced transistors developed in imec for 5G mmWave applications. These transistors, while fabricated on a Si platform, are made from GaN materials to enhance the power generation efficiency. You will be part of a research team in imec specialized in the fabrication and modelling of advanced RF transistors.

Ms Thesis Proposal 2:

Nano-ridge based Nanoscale Vacuum Channel Transistors (NVCTs) for THz communication systems

Supervisors: Bertrand Parvais (VUB/imec) / Piet Wambacq (VUB/imec) / Abhitosh Vais (imec)

Abstract
The scaling of complementary metal–oxide–semiconductor (CMOS) field-effect transistors (FETs) has led to feature sizes of (CMOS) field-effect transistors (FETs) has led to feature sizes of <10nm. Continuing to improve the speed of these devices, while simultaneously reducing their power consumption, has become a significant challenge. To maintain progress and meet the needs of emerging markets such as the Internet of Things (IoT), autonomous vehicles and mobile applications, the semiconductor industry is considering the heterogeneous integration of different components.
Vacuum electronics, which were central to electronics before being replaced by solid-state devices, also have the potential to play an enhanced role in the future. The scalability, integration, and low power consumption advantages of solid-state electronics have been realized by continuous advances in semiconductor process technology. The miniaturization of vacuum tubes, by utilizing state-of-the-art processing technologies, can also lead to higher integration and lower operation voltage and power consumption. The vacuum state provides superior electron transport compared to all semiconductors as collisions and scattering with the crystal lattice do not occur. Thus, the electron velocity in vacuum is much higher than the saturation velocity in silicon and other high mobility semiconductors such as germanium and gallium arsenide. Driven by a combination of well-known physics and adoption of state-of-the-art integrated circuit manufacturing, vacuum channel transistors with nanoscale feature sizes can now be fabricated and presents an interesting alternative for future high-speed communications systems.

The goal of this internship is:

1. To analyze the feasibility of combining heterogenous integration of different semiconductor materials to develop a high-speed and low power-loss NVCTs for more-than-THz communication systems of the future
2. To provide a suitable design of such an NVCT

You will be part of a research team in imec specialized in the fabrication and modelling of advanced RF transistors.

Ms Thesis Proposal 3:

Power amplifier design in GaN on Si technology.

Supervisors: Bertrand Parvais (VUB/imec) / Piet Wambacq (VUB/imec) / Mark Ingels (imec)

To accommodate the need for extremely high wireless communication rate up to multiple Gb/s, 5G uses RF spectrum in the mm-wave range around 28GHz and 39GHz. One of the major challenges to bring these capabilities to the consumer market lies in the availability of efficient and cost-effective power amplifiers. While Silicon circuits have been presented that work up to these frequencies, this technology struggles to provide sufficient power with high efficiency and in a compact footprint at these frequencies. On the other hand, III-V technologies offer these capabilities, but are typically too expensive to be used in a mass market. The integration of GaN transistors on Silicon wafers is a promising solution for the fabrication of high performance, cost-effective, power amplifiers.

In this Master's thesis, you will design and analyze mm-wave power amplifiers in imec's GaN on Si technology and draw conclusions on the optimal design choices for the targeted beam-forming mm-wave transmitter. You will also be in close contact with the technology development team and provide feedback on your experience with the technology itself and its modelling. The outcome of your thesis will be a thorough analysis of GaN on Si mm-wave PAs, giving advice on optimal design choices and on the usage and possible improvements on the technology modeling for circuit design.
You will be part of a research team in imec specialized in advanced RF technologies and circuits.